OSI Transport Layer

Network Fundamentals – Chapter 4

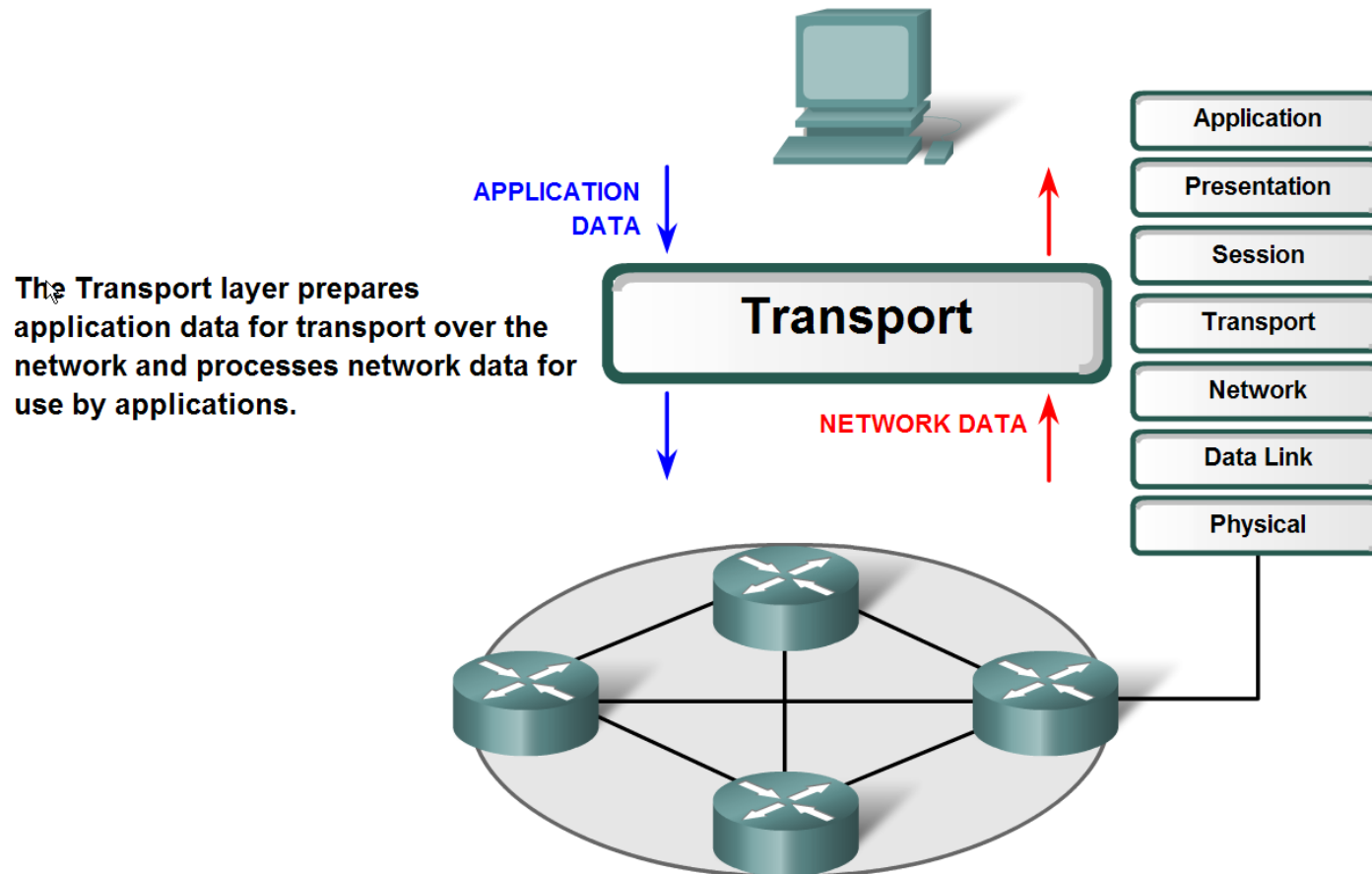Cisco | Networking Academy®
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Objectives

- Explain the role of Transport Layer protocols and services in supporting communications across data networks.

- Analyze the application and operation of TCP mechanisms that support reliability.

- Analyze the application and operation of TCP mechanisms that support reassembly and manage data loss.

- Analyze the operation of UDP to support communicate between two processes on end devices.

Transport Layer Role and Services

- Explain the purpose of the Transport layer

The OSI Transport Layer

The Transport layer prepares application data for transport over the network and processes network data for use by applications.
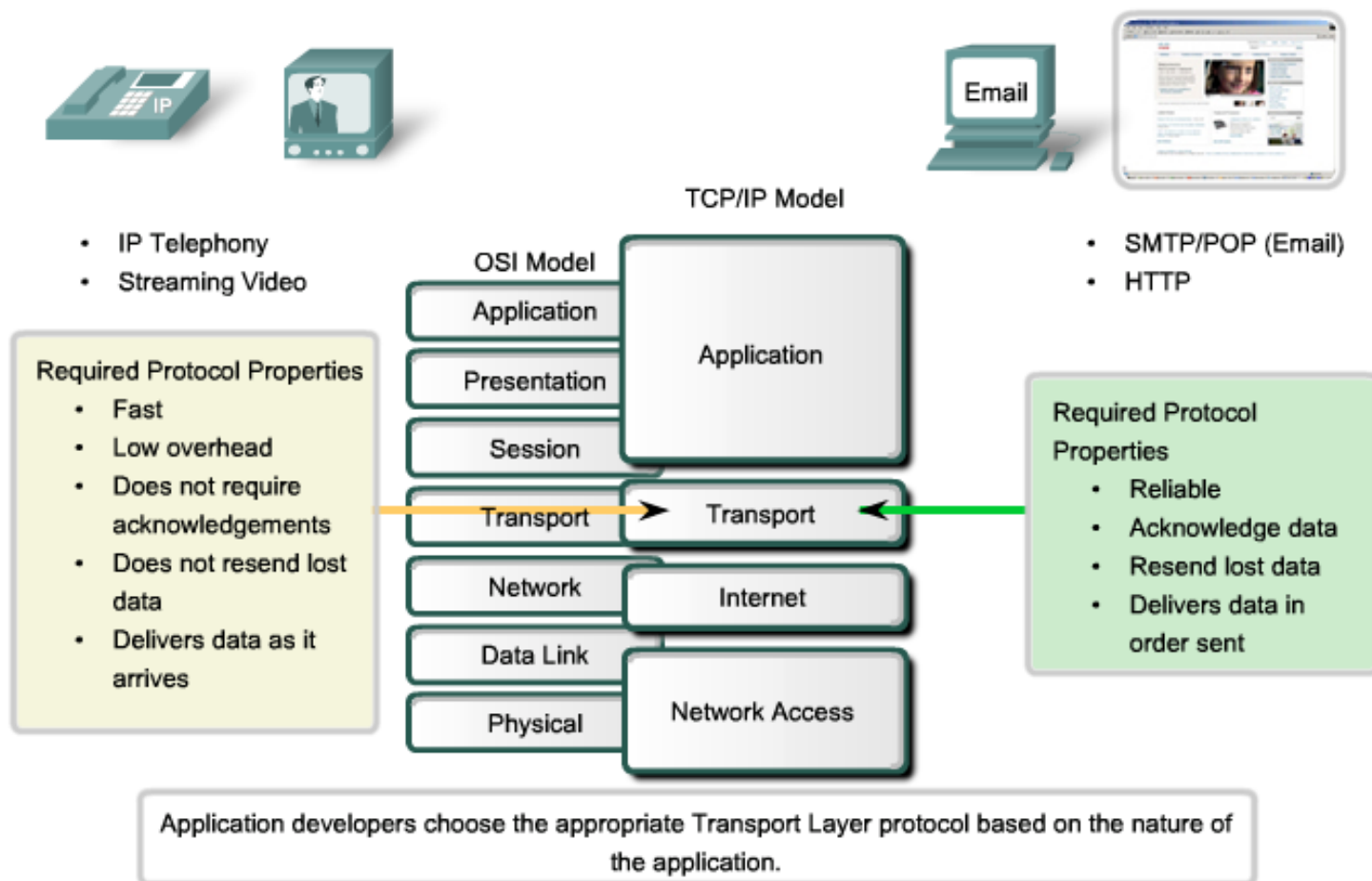
APPLICATION DATA

Transport

NETWORK DATA

Application
Presentation
Session
Transport
Network
Data Link
Physical

Transport Layer Role and Services

- Major functions of the transport layer and the role it plays in data networks

Enabling Applications on Devices to Communicate

TCP/IP Model

Application

Transport

Internet

Network Access

The Transport layer moves data between applications on devices in the network.

TCP/IP Model

Application

Transport

Internet

Network Access
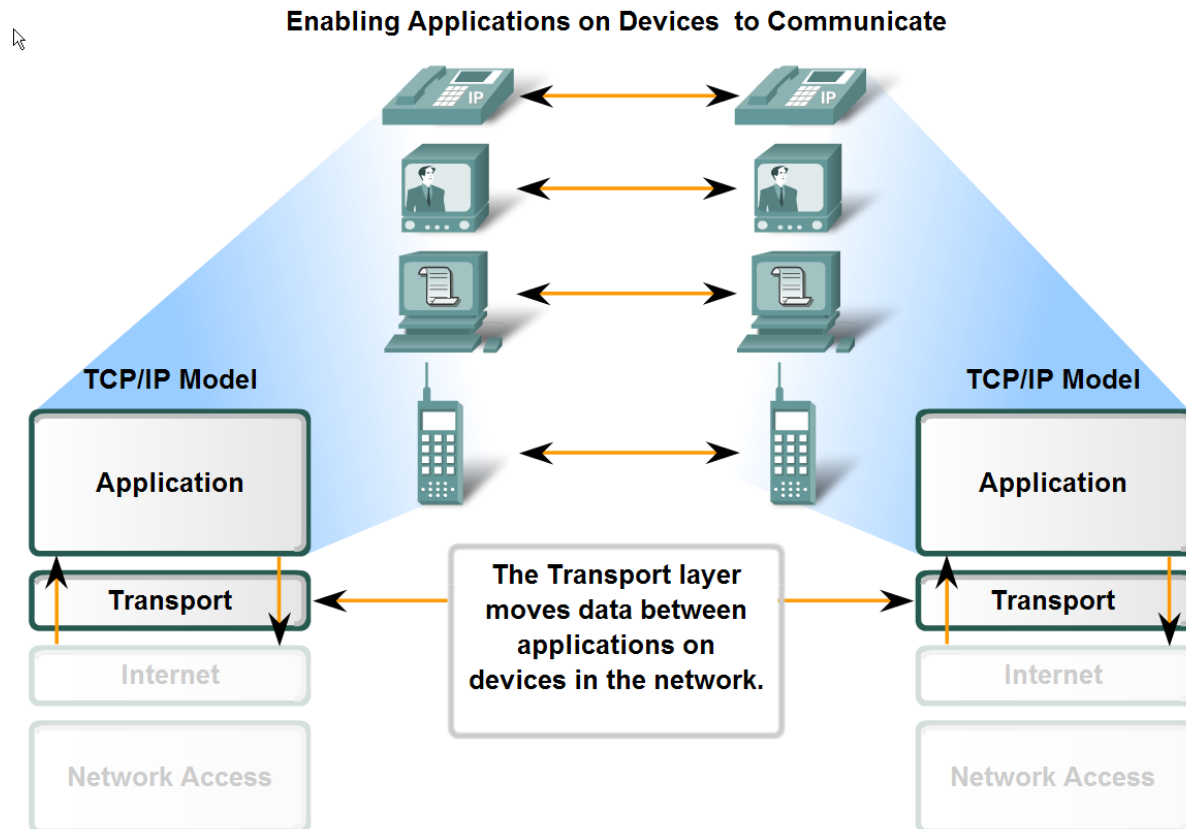
Transport Layer Role and Services

- Supporting Reliable Communication

Transport Layer Protocols

Email

- IP Telephony
- Streaming Video

TCP/IP Model

OSI Model

- SMTP/POP (Email)
- HTTP

Required Protocol Properties
- Fast
- Low overhead
- Does not require acknowledgements
- Does not resend lost data
- Delivers data as it arrives

OSI Model	TCP/IP Model
Application	Application
Presentation	
Session	
Transport	Transport
Network	Internet
Data Link	Network Access
Physical	

Required Protocol Properties
- Reliable
- Acknowledge data
- Resend lost data
- Delivers data in order sent

Application developers choose the appropriate Transport Layer protocol based on the nature of the application.

Transport Layer Role and Services

- Identify the basic characteristics of the UDP and TCP protocols

TCP and UDP Headers

TCP Segment

Bit (0)		Bit (15)	Bit (16)		Bit (31)
Source Port (16)			Destination Port (16)		
Sequence Number (32)					
Acknowledgement Number (32)					
Header Length (4) Reserved (6) Code Bits (6)			Window (16)		
Checksum (16)			Urgent (16)		
Options (0 or 32 if any)					
APPLICATION LAYER DATA (Size varies)					

20 Bytes

UDP Datagram

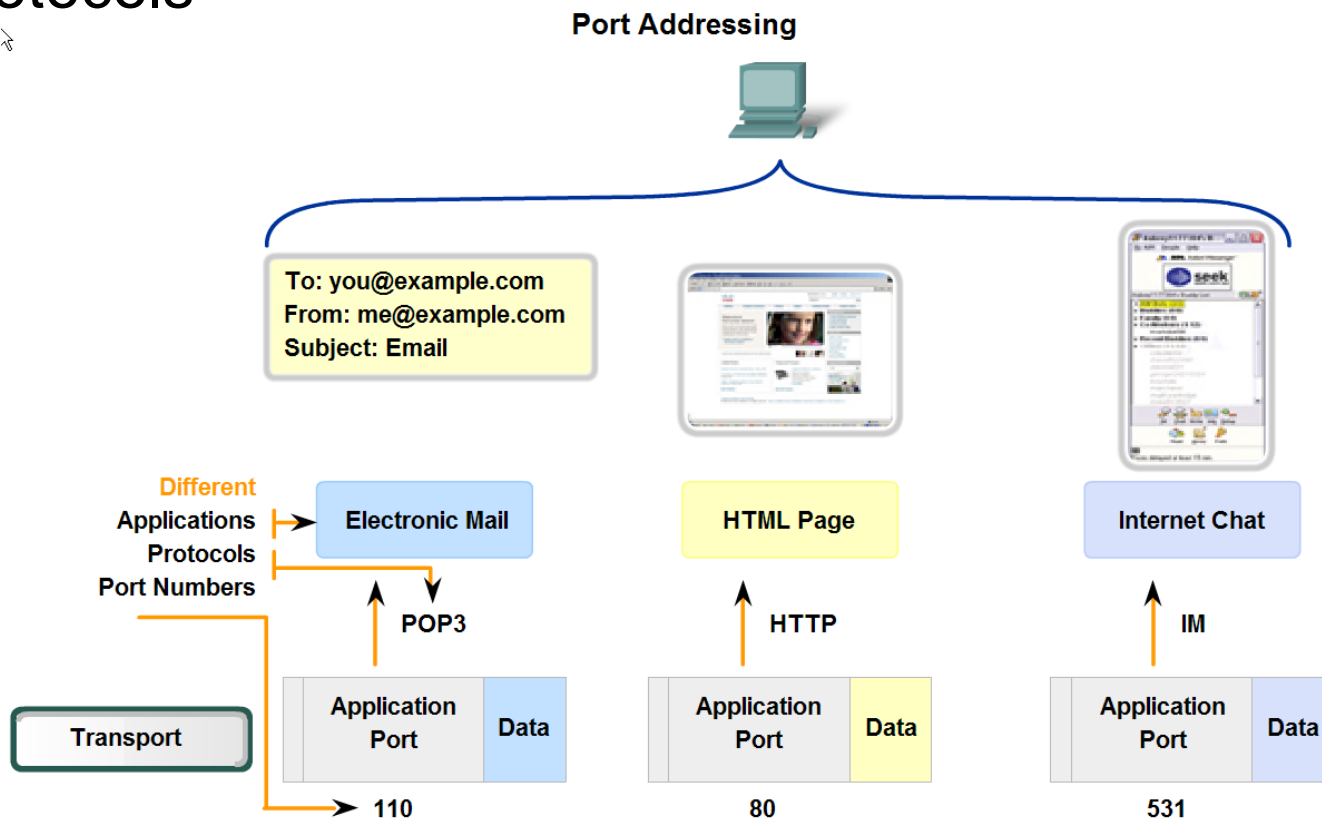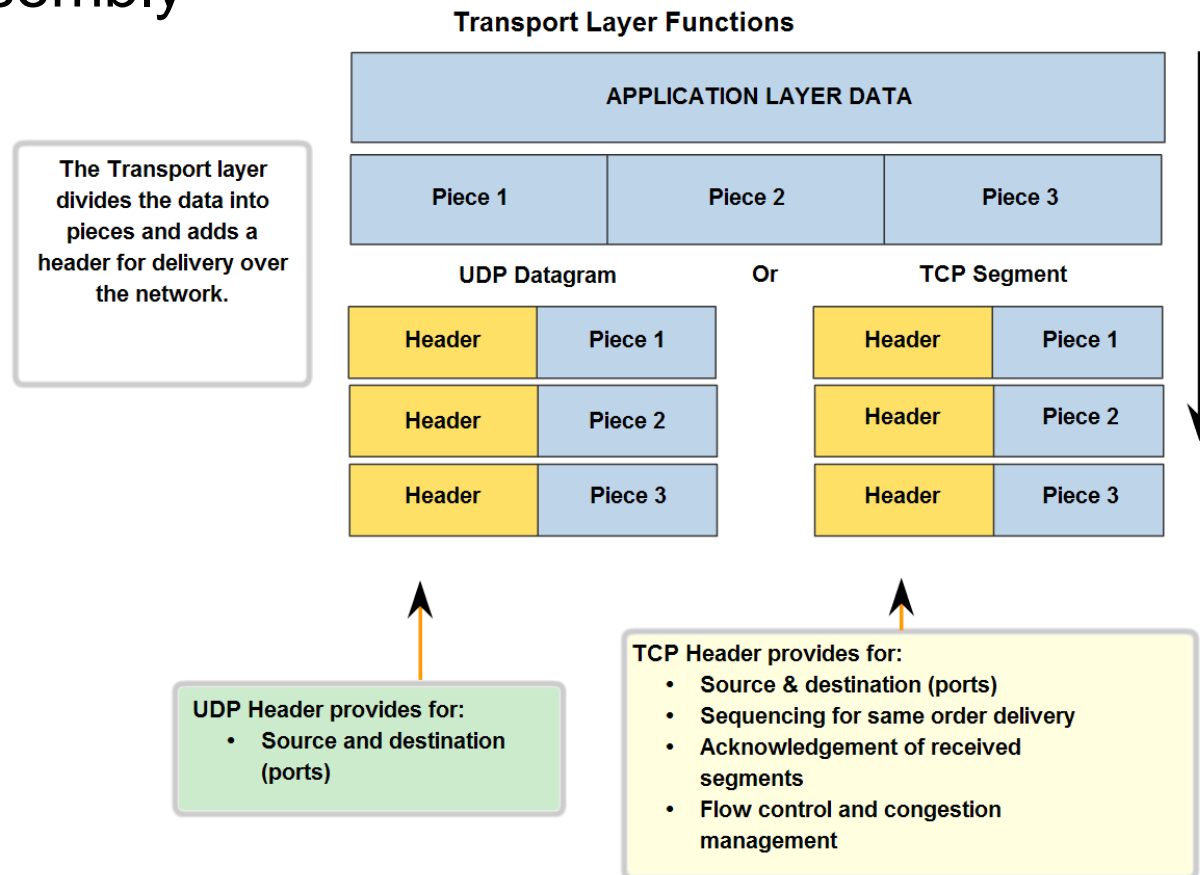| Bit (0)	Bit (15)	Bit (16)	Bit (31)
Source Port (16)		Destination Port (16)	
Length (16)		Checksum (16)	
APPLICATION LAYER DATA (Size varies)			

8 Bytes
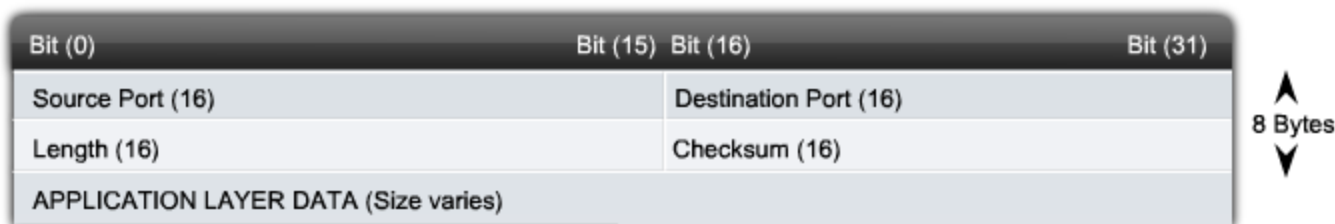
Transport Layer Role and Services

- Identify how a port number is represented and describe the role port numbers play in the TCP and UDP protocols

Port Addressing

To: you@example.com
From: me@example.com
Subject: Email

Different
Applications
Protocols
Port Numbers

| Electronic Mail | HTML Page | Internet Chat |

POP3   HTTP   IM

Transport

Application Port	Data
Application Port	Data
Application Port	Data

110   80   531

Data for different applications is directed to the correct application because each application has a unique port number.

Transport Layer Role and Services

- Describe the role of segments in the transport layer and the two principle ways segments can be marked for reassembly

Transport Layer Functions

The Transport layer divides the data into pieces and adds a header for delivery over the network.

APPLICATION LAYER DATA		
Piece 1	Piece 2	Piece 3

UDP Datagram   Or   **TCP Segment**

Header	Piece 1
Header	Piece 2
Header	Piece 3

Header	Piece 1
Header	Piece 2
Header	Piece 3

UDP Header provides for:
- Source and destination (ports)

TCP Header provides for:
- Source & destination (ports)
- Sequencing for same order delivery
- Acknowledgement of received segments
- Flow control and congestion management

Application and Operation of TCP Mechanisms

- Trace the steps that show how the TCP reliability mechanism works as part of a session

TCP Segment Header Fields

Bit 0			15	31
Source Port Number			Destination Port Number	
Sequence Number				
Acknowledgement Number				
H.Length	(Reserved)	Flags	Window Size	
TCP Checksum			Urgent Pointer	
Options (if any)				
Data.....				

The fields of the TCP header enable TCP to provide connection-oriented, reliable data communications.

Application and Operation of TCP Mechanisms

- Describe the role of port numbers in establishing TCP sessions and directing segments to server process

Clients Sending TCP Requests

HTTP response:
Source Port 80
Destination Port 49152

Server

SMTP Response:
Source Port 25
Destination Port 51152

HTTP: Port 80
SMTP: Port 25

Client 1

Client 2

Client requests to TCP server

HTTP Request:
Source Port: 49152
Destination Port: 80

Server response to TCP clients use random port numbers as the destination port.

SMTP Request:
Source Port: 51152
Destination Port: 25
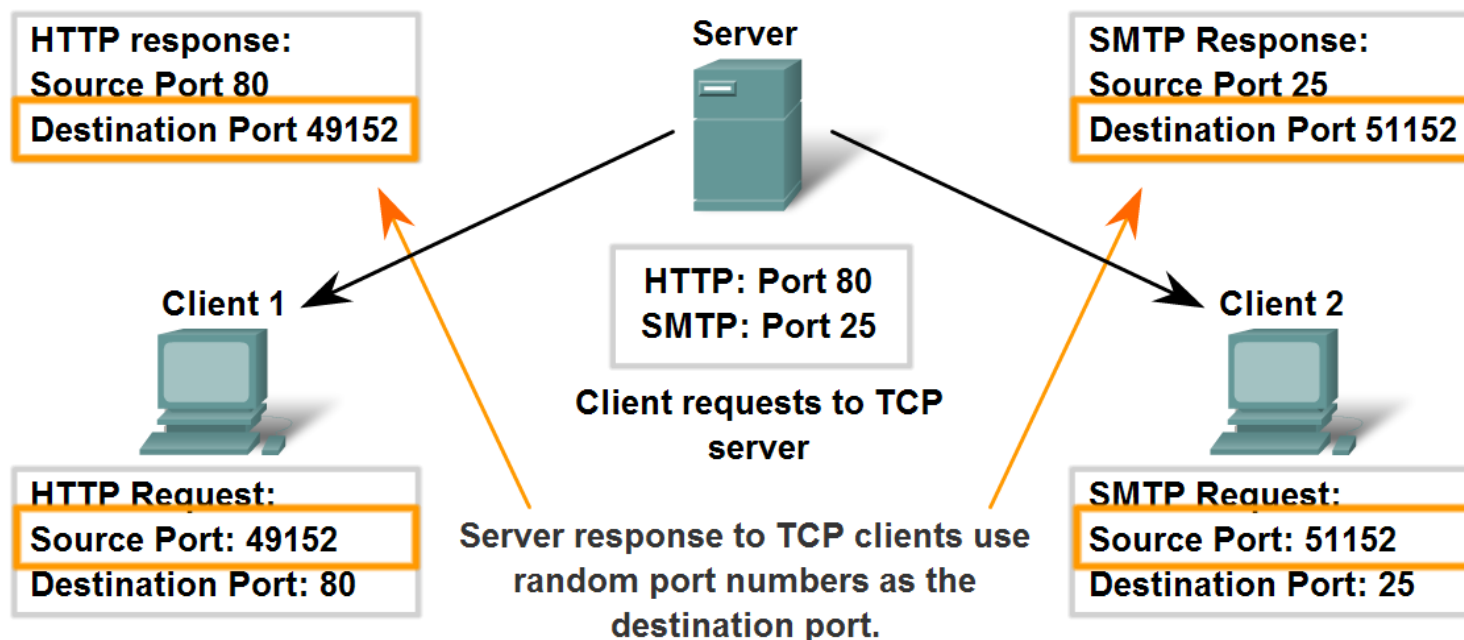
Application and Operation of TCP Mechanisms

- Trace the steps in the handshake in the establishment of TCP sessions

TCP Connection Establishment and Termination

A   B

1 Send FIN → FIN received

ACK received ← Send ACK 2

Send FIN 3

FIN received ← Send FIN

4 Send ACK → ACK received
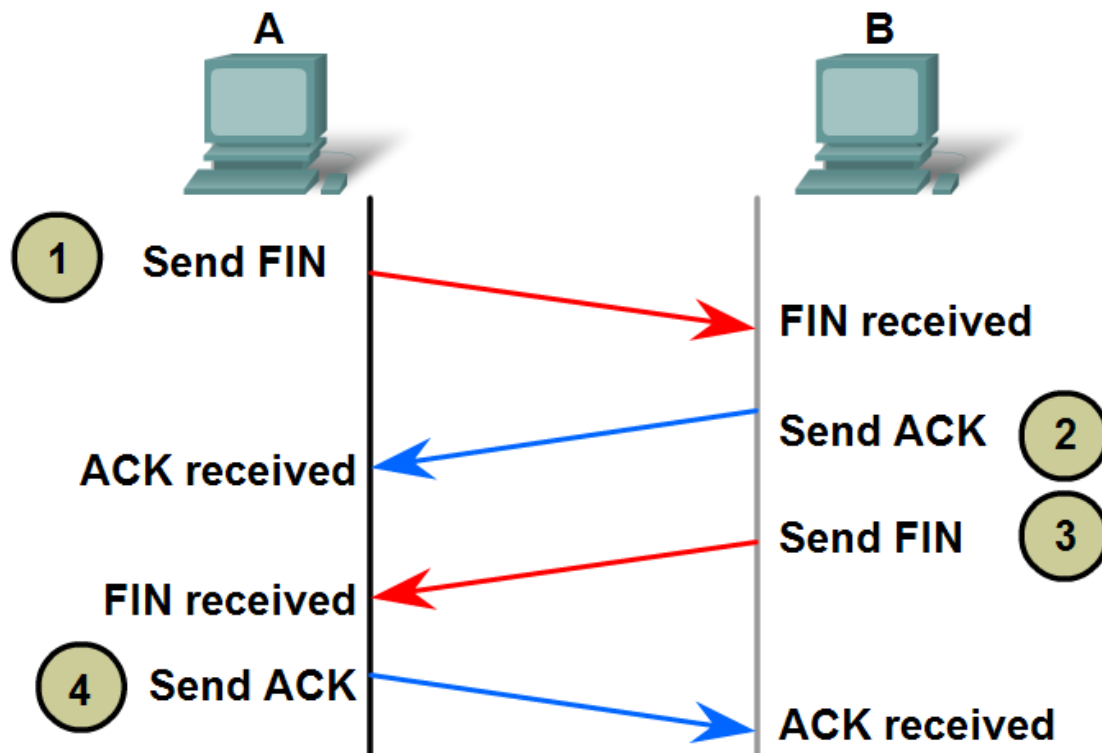
Application and Operation of TCP Mechanisms

- Trace the steps in the handshake in the termination of TCP sessions

TCP Connection Establishment and Termination

Session Terminated
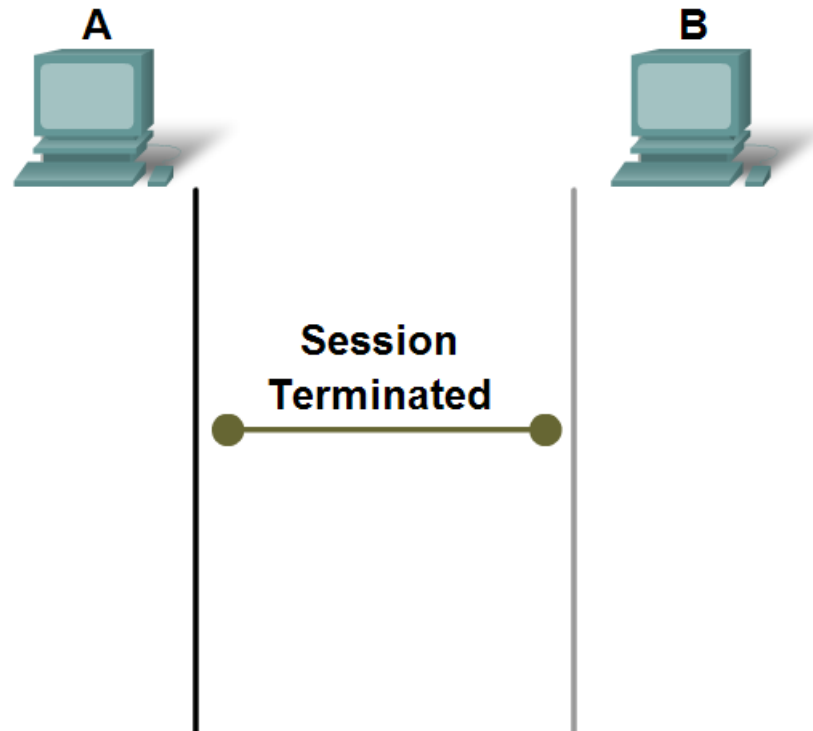
Managing TCP Sessions

- Describe how TCP sequence numbers are used to reconstruct the data stream with segments placed in the correct order

TCP Segments Are Re-Ordered at the Destination
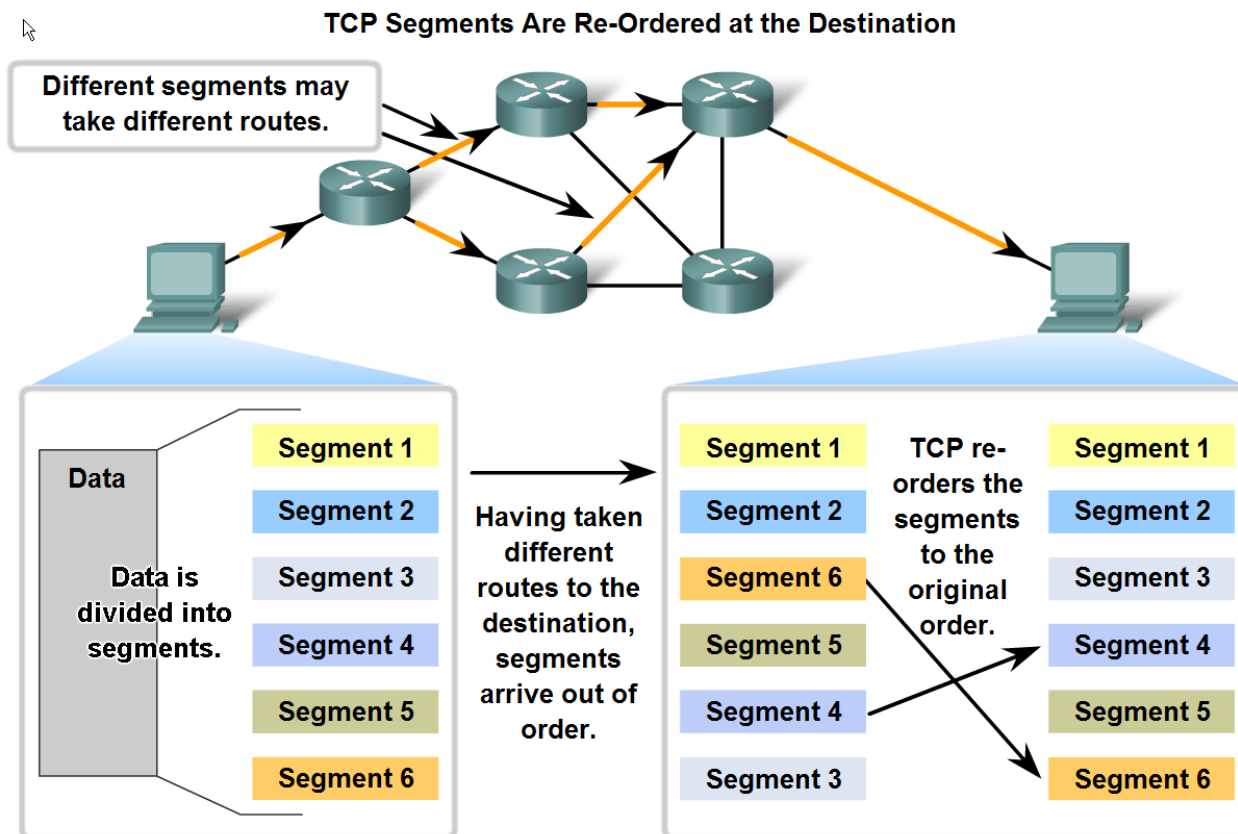
Managing TCP Sessions

- Trace the steps used by the TCP protocol in which sequence numbers and acknowledgement numbers are used to manage exchanges in a conversation

Acknowledgement of TCP Segments

Managing TCP Sessions

- Describe the retransmission remedy for lost data employed by TCP
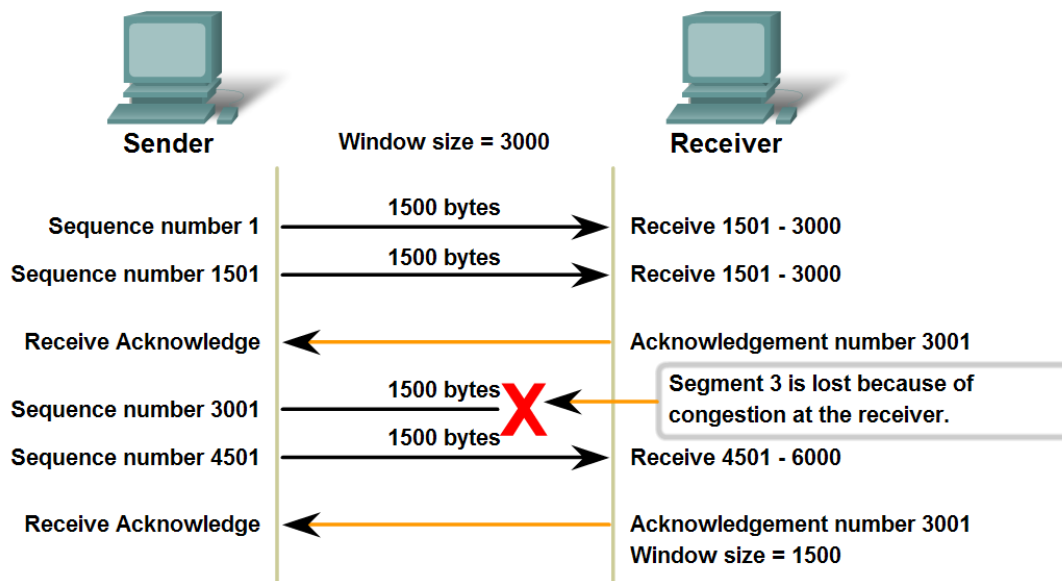
TCP Retransmission
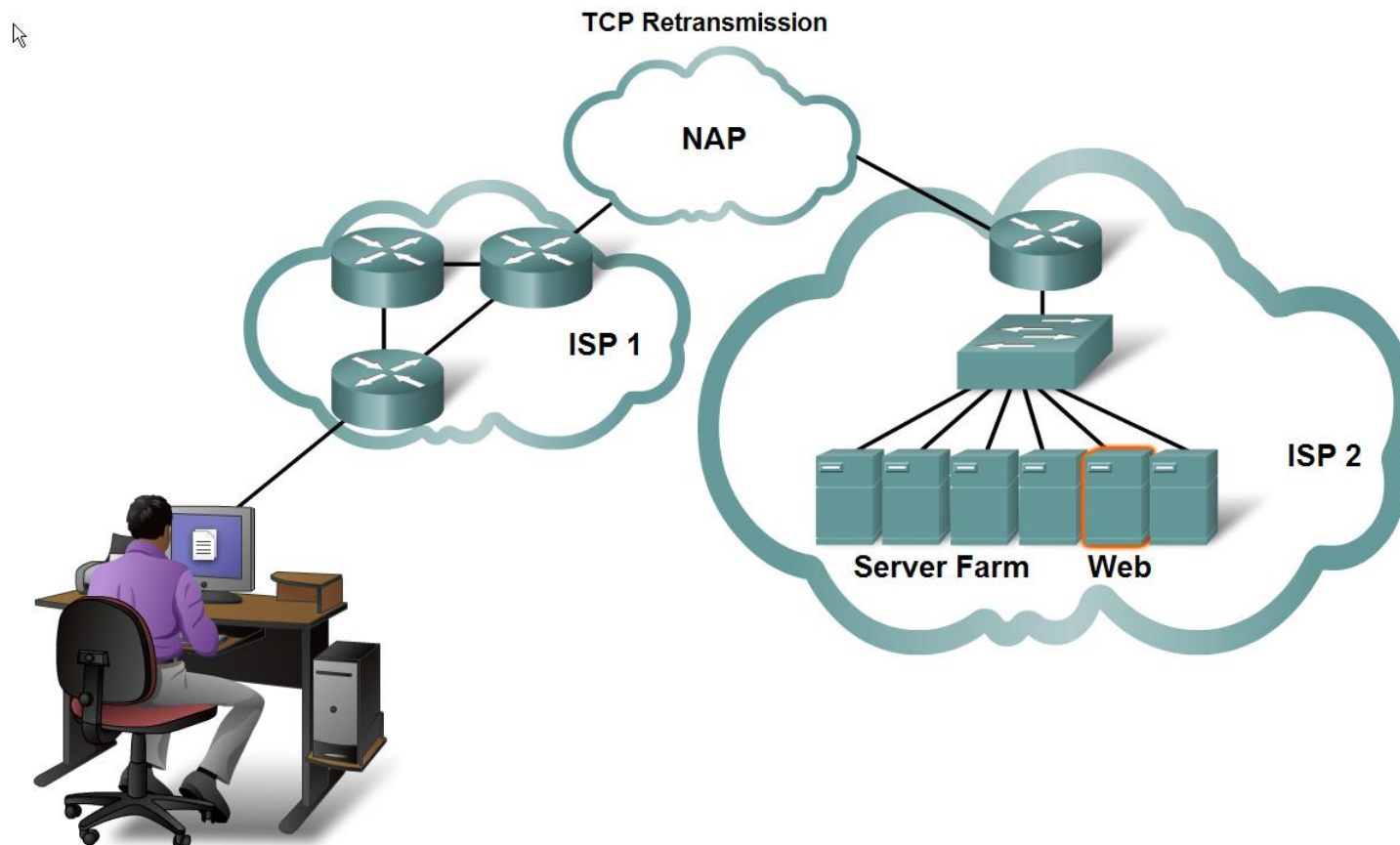
Managing TCP Sessions

- Describe the mechanisms in TCP that manage the interrelationship between window size, data loss and congestion during a session
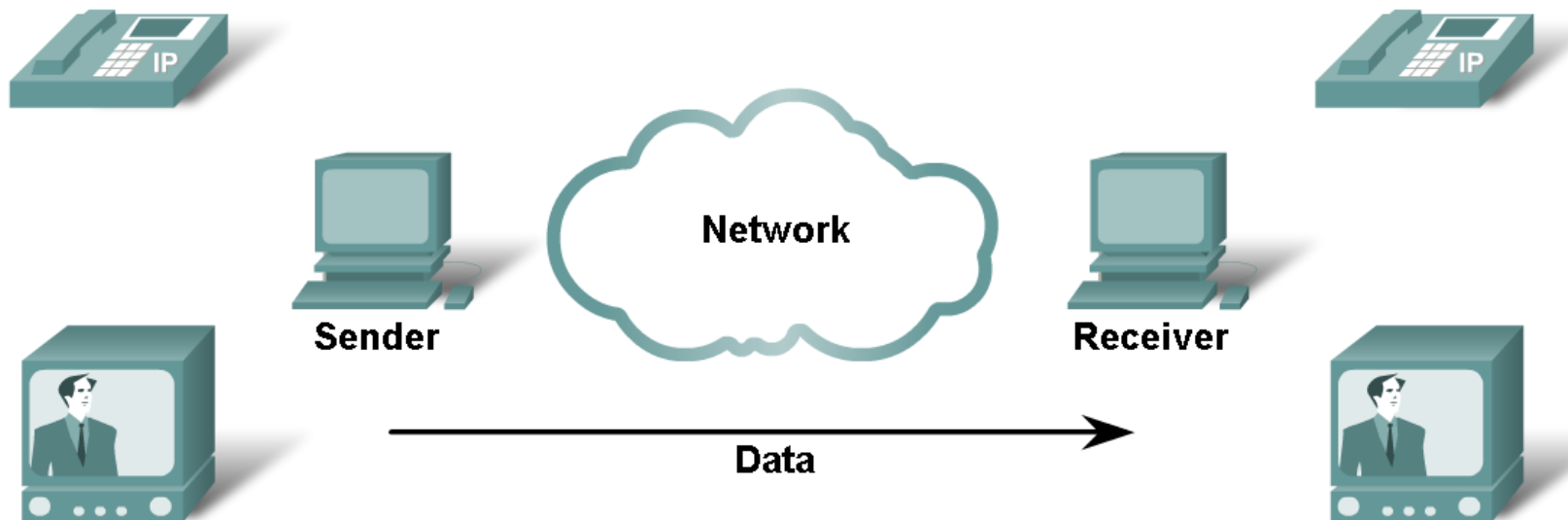
TCP Congestion and Flow Control

If segments are lost because of congestion, the Receiver will acknowledge the last received sequential segment and reply with a reduced window size.

UDP Protocol

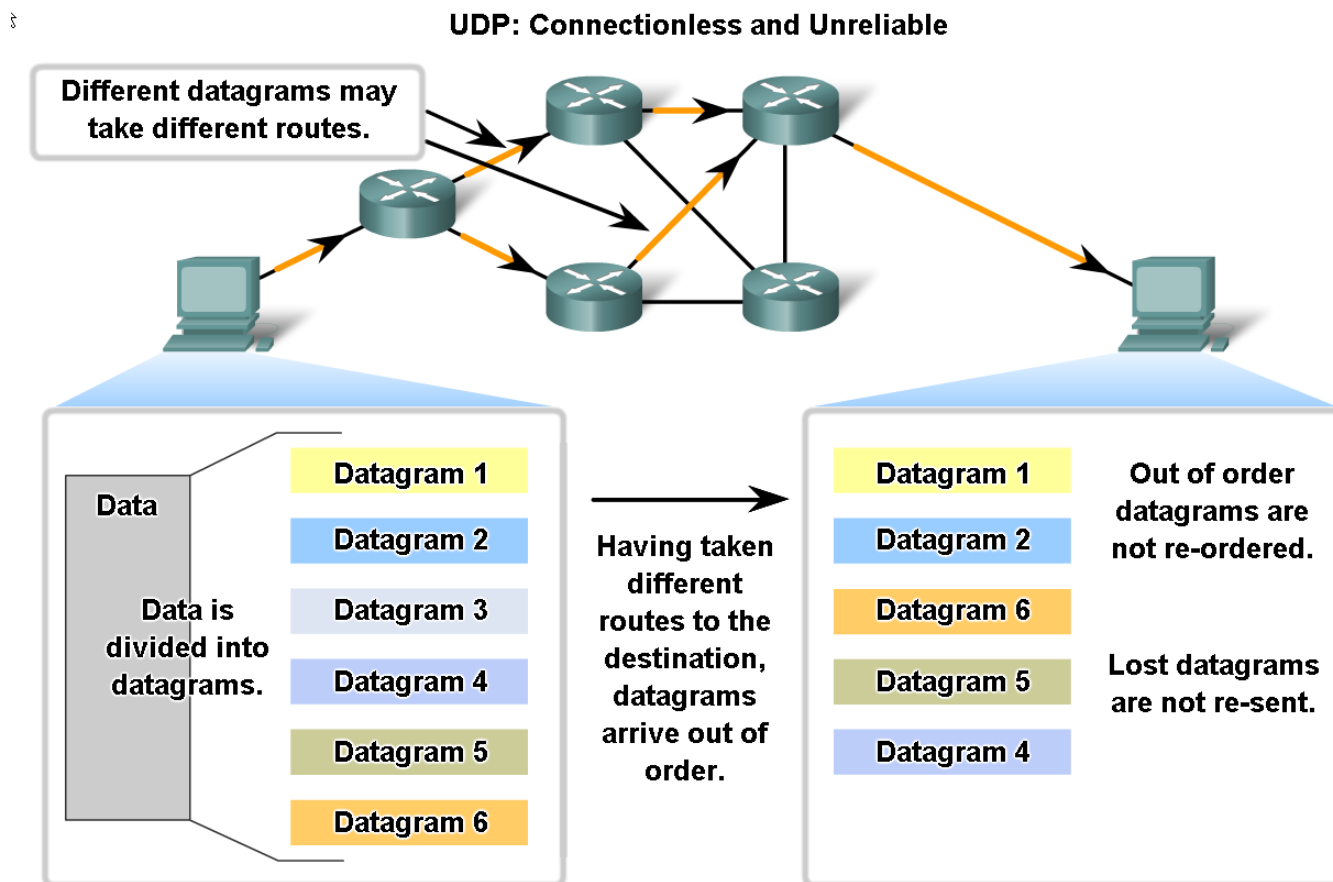- Describe the characteristics of the UDP protocol and the types of communication for which it is best suited

UDP Low Overhead Data Transport

Network

Sender

Receiver

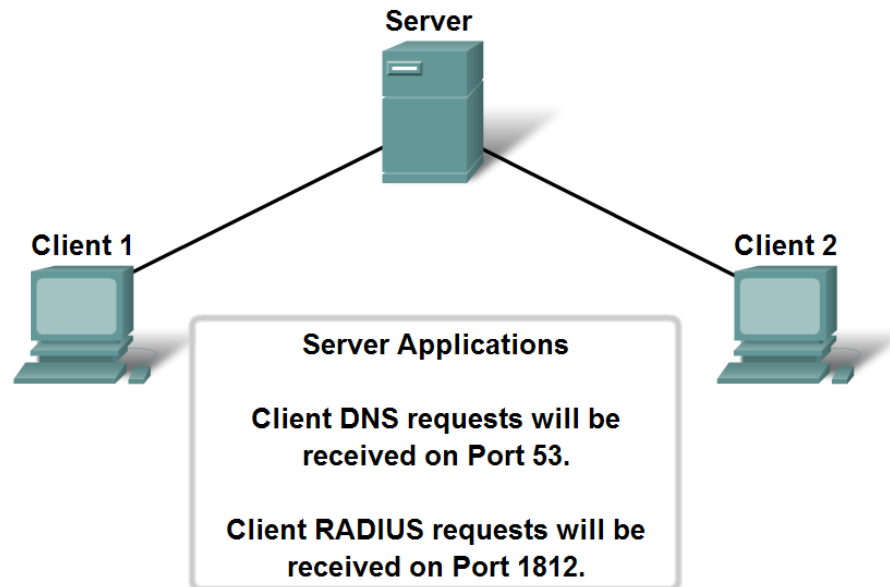Data

UDP does not establish a connection before sending data.

UDP Protocol

- Describe in detail the process specified by the UDP protocol to reassemble PDUs at the destination device

UDP: Connectionless and Unreliable

Different datagrams may take different routes.

Data

Data is divided into datagrams.

| Datagram 1 |
| Datagram 2 |
| Datagram 3 |
| Datagram 4 |
| Datagram 5 |
| Datagram 6 |

Having taken different routes to the destination, datagrams arrive out of order.

| Datagram 1 |
| Datagram 2 |
| Datagram 6 |
| Datagram 5 |
| Datagram 4 |

Out of order datagrams are not re-ordered.

Lost datagrams are not re-sent.

UDP Protocol

- Describe how servers use port numbers to identify a specified application layer process and direct segments to the proper service or application
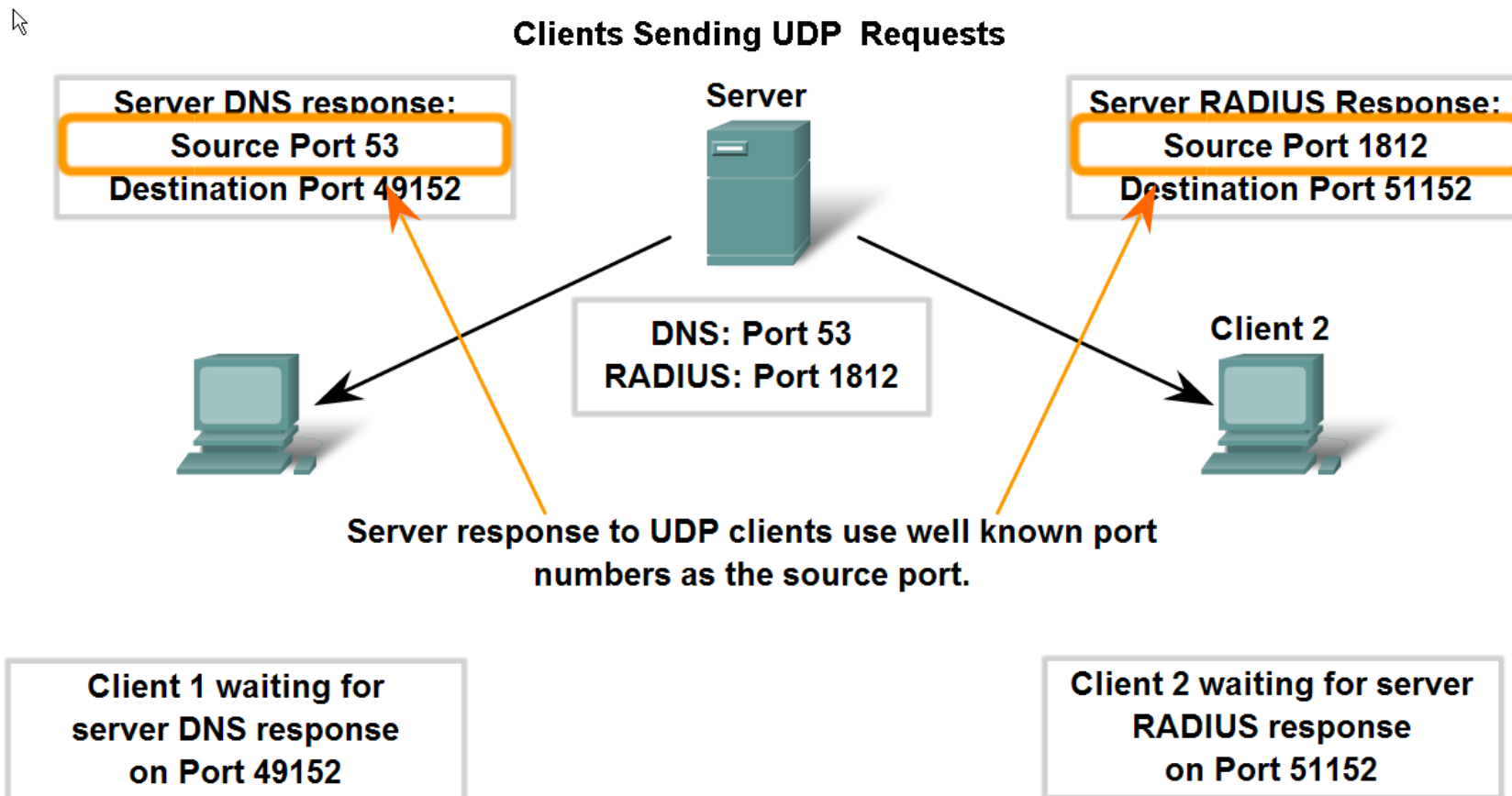
UDP Server Listening for Requests

Server

Client 1

Client 2

Server Applications

Client DNS requests will be received on Port 53.

Client RADIUS requests will be received on Port 1812.

Client requests to servers have well known ports numbers as the destination port.

UDP Protocol

- Trace the steps as the UDP protocol and port numbers are utilized in client-server communication

Clients Sending UDP Requests

Server

Server DNS response:
Source Port 53
Destination Port 49152

Server RADIUS Response:
Source Port 1812
Destination Port 51152

DNS: Port 53
RADIUS: Port 1812

Client 2

Server response to UDP clients use well known port numbers as the source port.

Client 1 waiting for server DNS response on Port 49152

Client 2 waiting for server RADIUS response on Port 51152

Summary

In this chapter, you learned to:

- Explain the need for the Transport layer
- Identify the role of the Transport layer as it provides the end-to-end transfer of data between applications
- Describe the role of two TCP/IP Transport layer protocols, TCP and UDP
- Explain the key functions of the Transport layer including reliability, port addressing, and segmentation
- Explain how TCP and UDP each handle these key functions
- Identify when it is appropriate to use TCP or UDP and provide examples of applications that use each protocol

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